The SOFIA Water-Vapor Monitor

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The Stratospheric Observatory for Infrared Astronomy (SOFIA), a 3-meter class telescope mounted in a Boeing 747 aircraft, is being developed for NASA by a consortium consisting of the University Space Research Association, Raytheon E-Systems, and United Airlines. This new facility will be a replacement for the retired Kuiper Airborne Observatory that used to fly out of Moffett Field. As part of this development, Ames Research Center is providing an instrument that will measure the integrated amount of water vapor seen along the telescope line of sight. Because the presence of water vapor strongly affects the astronomical infrared signals detected, such a water-vapor monitor (WVM) is critical for proper calibration of the observed emission. The design and engineering model development of the WVM is now complete, and the hardware to be used in the flight unit is being fabricated and tested.

The SOFIA WVM (figure 1) measures the water-vapor content of the atmosphere integrated along the line of sight at a 40-degree elevation angle by making radiometric measurements of the center and wings of the 183.3-gigahertz (GHz) rotational line of water. These measurements are then converted to the integrated water vapor along the telescope line of sight. The monitor hardware consists of three physically distinct subsystems:

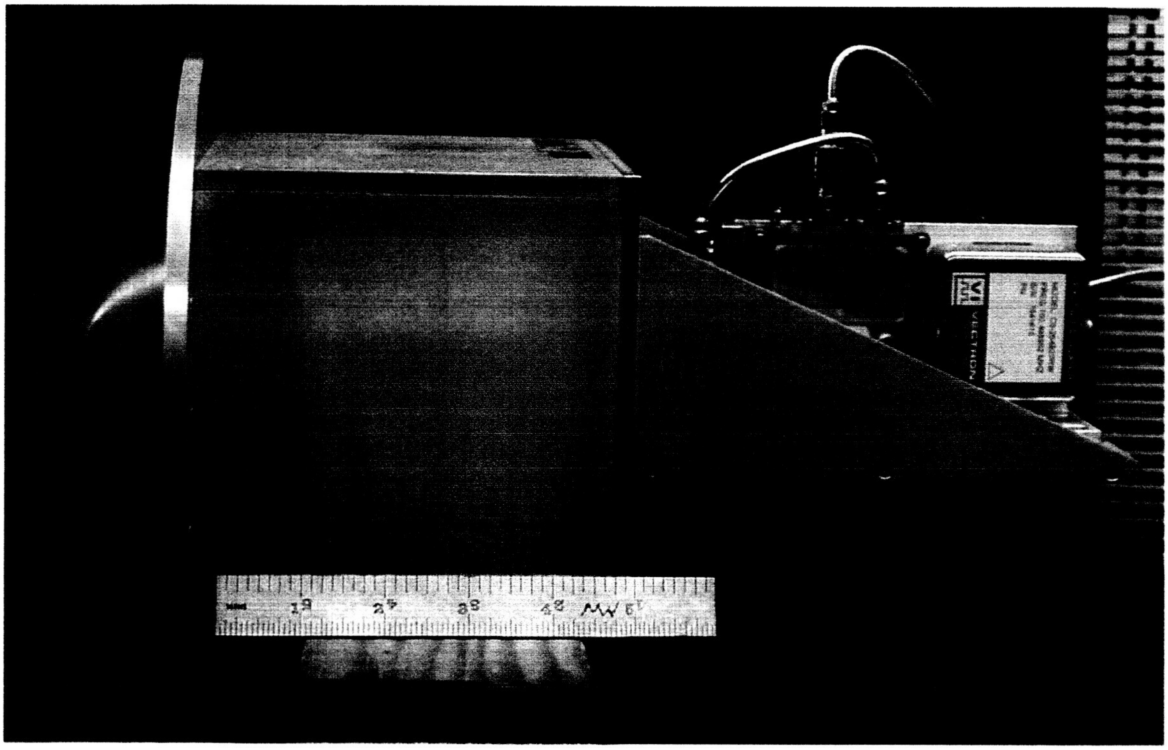

Fig. 1. The SOFIA water-vapor monitor 183-GHz radiometer assembly.

1. The radiometer head assembly, which contains an antenna that views the sky, a calibrated reference target, a radio-frequency (RF) switch, a mixer, a local oscillator, and an intermediate-frequency (IF) amplifier—all these components are mounted together and attached to the inner surface of the aircraft fuselage, so that the antenna can observe the sky through a microwave-transparent window. The radiometer and antenna were ordered from a commercial vendor and modified at Ames to include an internal reference calibrator. Laboratory tests of this subassembly have indicated a signal-to-noise performance over a factor of two better than required.

2. The IF converter box assembly, which consists of IF filters, IF power splitters, RF amplifiers, RF power meters, analog amplifiers, analog-to-digital (A/D) converters, and an RS-232 serial interface driver—these electronics are mounted in a cabinet just under the radiometer head and connected to both the radiometer head and a dedicated WVM computer (CPU). All the flight electronic boards have been fabricated and have been shown through testing to meet their requirements. A small microprocessor that handles the lowest-level data collection and timing has been programmed in assembly language to collect and co-add the radiometer data and communicate with the software residing in the WVM CPU.

3. A dedicated WVM CPU that converts the radiometer measurements to measured microns of precipitable water and communicates with the rest of the SOFIA Mission and Communications Control System (MCCS)—a nonflight version of this computer hardware has been procured for laboratory testing and the flight software is under development, with approximately 60% of the software coded and unit tested. Proper command and data communications between the WVM and the SOFIA MCCS have been demonstrated using an MCCS simulator that was developed by the SOFIA Project and is located on site at Ames.

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New Interstellar Simulation Chamber Cavity Ring-Down Spectroscopy of Interstellar Organic Materials

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A major milestone has just been achieved at Ames Research Center: a new facility has been developed to directly simulate gaseous molecules and ions at the low temperature and pressure conditions of interstellar space. This laboratory facility—which is unique within NASA—combines the techniques of supersonic free-jet expansion spectroscopy (JES) with the techniques of cavity ring-down absorption spectroscopy (CRDS). The principal objective is to determine the spectroscopic properties of large interstellar aromatic molecules and ions under conditions that precisely mimic interstellar conditions. The aim of this research is to provide quantitative information to analyze astronomical spectra in support of NASA's Space Science and Astrobiology missions, including data taken with the Hubble Space Telescope.

Understanding the origin, physical properties, and distribution of the most complex organic